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SEX.

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NIEBUHR, the great historian, said that traditions should not be thrown aside in the study of the history of nations. What was enunciated by him respecting the history of nations might be accepted as true regarding the ætiology and biology of man. Though many of the myths and traditions are erroneous and not literally true, still in many instances they are founded upon fact. As far back as history carries us, we find the prevalence of the Phallic worship. It has been computed by some authorities that the monuments of that worship can be traced back eleven or twelve thousand years, and on their sides can be seen the representation of the sexes, from which we learn some of the ideas entertained respecting their production and origin.

The egg has ever been the symbol both of female and male. The ancient Hindus, Assyrians and other nations held that the right egg of the male germinated boys, whilst the left produced girls. This idea of sex obtained a place in their religion as typified in the representation of some of the divinities with both sexes combined in one body, the right side being male, with the emblem of the male procreative power in the right hand, and the left being female, with emblems of the female organs of generation in the left hand, and the centre, *i. e.*, the privates, with the emblems of both male and female united, as is seen in the divinity, Parvati. When I began my experiments on sex, nine years ago, I was not aware that the above and other theories had been advanced. It was some time before I narrowed the question down to the testicles. Had I commenced my experiments upon the bipeds, I should have arrived at my conclusions more speedily and with less labor, as I shall demonstrate further on. My ex-

periments may not be convincing to some, still I hope they will have the effect of interesting a few in the subject, and of having similar and other experiments repeated. There are many obstacles in the study of the origin of sexes. We should not limit our inquiries to any one species of a genus. It is necessary in the investigation of reproduction to go back to the first forms of life. The division of sexes into male and female, which is seen throughout nature, in the higher organized forms being symmetrical in both sexes, is the result of development. In some of the lower forms of life each organism reproduced itself, but as the organism became more complex, due to adaptation and inheritance, the sexes became separate. By a sexual union of the two the future organism was produced.

As is well known, reproduction takes place, *non-sexually*, by its several methods, and *sexually*, which is the usual method among the higher animals and plants. This method was evolved at a comparatively late period of the earth's history, from non-sexual propagation by *germ cells*. These changes were neither sudden nor spasmodic; thousands of years elapsed before it was accomplished. In sexual propagation, the earliest examples are the hermaphrodites, double-sexed organisms, having the peculiar properties which characterize both sexes. Some species are capable of fructifying themselves; in others it is necessary that a union of the hermaphrodites should take place. From hermaphroditism sexual separation was developed. In some species of a class we find examples of hermaphroditism in some of its members, and in others sexual separation.

In some Infusoria reproduction is effected by sexual union, *i. e.*, the union of the germ and sperm, while others of the same species under certain conditions are agomonegetic, *i. e.*, propagate non-sexually, either fissiparously or gemmiparously. Thus, in this ascent of development, changes and relapses are noticed in the species of the same classes of the Invertebrates. In Parthenogenesis is seen a relapsing into the non-sexual reproduction, a division as yet not fully explained.

It is but reasonable to conclude that the more highly developed organism is the outgrowth of natural laws established by a Supreme power, the reproduction of which organism is amena-

ble to the laws of adaptation and inheritance. Propagation is carried on throughout nature by one and the same action, though morphologically different, whether sexual or agamogenetic; the forms are dissimilar, but the result is the same. In the product of propagation we are struck with the hereditыof the resemblance of the offspring to the procreators. Not only does the offspring resemble the parents, which physiological fact is not usually appreciated, but the likeness, in some particulars, very often may be traced back several generations. The most prominent hypotheses advanced to account for these phenomena are, viz., the one by Darwin, viz., The Provisional Hypothesis of Pangenesis, and later on, The Perigenesis of the Plastidules, by Haeckel. The pioneers in the elucidation of the theory of Descent and Selection have never received their just dues. To Goethe and Lamarck great credit and praise belong. Oken said that man was developed, not created. What he said of man might be equally well said of all organisms. Man has ascended from the lower organisms.

In attempting to throw some light upon this subject I do not wish to appeai "to rush in where angels fear to tread." Laws have been established adequate to account for all the existing phenomena. If we would know, we must seek and find. It is this spirit of *laissez nous faire* that has proved the incubus to progress, civilization and reform. To say that God does not intend that humanity shall understand his laws but begs the question. It is not logical, it is not progressive; it will fail to stem the tide of enquiry. At one time, not very remote, it was denied that the mid-jaw bone existed in man, which was considered so necessary to establish the theory of descent as applied to man. Goethe was convinced that it did exist, and persevered till he found an example of it. He claimed that it must, of necessity, exist. Cuvier, in his scientific conflict with G. de St. Hilaire, was supposed to have got the better of his antagonist. After thirty years the monistic views advocated by Geoffrey and Lamarck prevailed, as predicted by Goethe they would. At first the illustrious men, with Oken, the forerunners of Darwin in establishing the theory of organic development, were in the minority. Now, Cuvier's triumph is of the past.

In the development of organisms we are struck with the manifold forms of kindred genera and classes. We see the succession of classes of vertebrate animals from the Fishes upward through the Amphibia and the Mammals, and through the Mammals, in succession. More difficult is it to follow the succession in the Invertebrates. In them we do not uniformly find the symmetrical division of the sexes. In some cases there are more than two testes and ovaries, and in others one. In some of the primitive fishes, also, where it is almost impossible to distinguish the male from the female, here is, to all appearances, but one testicle, though in some species, a groove in the centre, marking the beginning of division into two, is seen. No two offsprings of the same parrents, even, are alike; much less so would we expect the offsprings of different parents to be so. Far less is this the case in Invertebrates, where, in some cases, there are more than two testicles (in some instances, six testicles) and as many ovaries. It is a fact that the union of two sexual elements will produce variability, with hereditary species characteristics. This fact is offered to explain, in great measure, the many varieties of species of genera that have been noticed by different investigators. It will make clear the many *malae species* and *bonae species* about which there has been so much fruitless contention.

When I began myexperiments, on the determination of sex, I was neither an ovist nor a testist, nor did I pin my faith to epigenesis. In a former paper I described these experiments, and the results. I observed that there exists a great attraction between the products of the testicles and the products of the ovaries; that this obtains in the greatest intensity between the ova and zoosperms of the corresponding side, as, for instance, between the *right male* ovum from the right ovary and the *right male* zoosperms from the *right* testicle; and also between the *left female* ovum from the *left* ovary and the *left female* zoosperms from the *left* testicle. I referred to the fact that Darwin had demonstrated the existence of this same law in the fertilization of plants; that when two varieties of pollen are mixed together and applied to the stigma of the pistil, it displays its powers of selection, and will take one particular kind *only* from the several varieties, there being always *one* for which it has the

greatest affinity. Should this not be present, it will evince a preference for the one that is nearest to that for which it has the greatest attraction. This law is assisted in some classes of vertebrates by the *position* of the female immediately after a fruitful coitus. In others the position would not affect the impregnation. In animals in which the power of generation is less complete, as in osseous fishes, the ova are impregnated externally to the body of the female by the semen of the male, which is emitted loosely into the water, and those germ and sperm cells unite, which have the greatest attraction or affinity for each other. In all classes of animals this principle of affinity is carried out in reproduction, but modified according to the requirements of each class. Birds (generally) possess two sensitive papillæ, two *penes*, as it were, which are merely capable of juxtaposition. During copulation, the fluid escapes separately from each papilla, in all probability not simultaneously, assisting thereby the principle of sexual selection.

From experiments on dogs I am convinced that the testicles and ovaries, in their physiological function, are similar to the other organs of the body, as the liver, and do not act co-ordinately with each other, as in the action of the parotid glands, but are intermittent; do not act with equal energy, nor simultaneously. If this is so, and I do not doubt it, it would play a most important role in the productive phenomena of the lower animals, especially those that have no vesiculæ seminales, and where the female does not assume a lateral position or has but one active ovarium. Particularly is this so in the impregnation of Birds, where the *sperm* cells from the testicles do not pass into the hen simultaneously, but rather successively and at different connections. As the impregnation of the Bird is not so complex as in the more highly organized animals, I shall confine my remarks, in this paper, to this class, and refer the reader to another paper relating to impregnation in mammals. In my experiments on Birds I take the barnyard fowl as the representative and martyr. In Birds the position of the animal would not influence the impregnation, for there is but one (active) fruitful ovary in the bird, and it would be almost impossible for the hen to assume, *naturally*, a lateral position. Evidently, then, the female in this class is passive in

the act of transmission of life. The determining principle, then, resides evidently in the male. To regulate the sex in the bird it is necessary to operate on the male, to partially caponize the rooster. As the *right* testicle represents the *male* principle and the *left* testicle the female, should a rooster be desired, the *left* testicle should be removed; should pullets be desired, the *right* testicle should be removed. The roosters selected for experiment should be young, as the operation is more apt to be successful. Should the rooster have attained his virility before partial emasculation, he should be allowed to tread the hens a number of times before using the eggs impregnated by him for hatching, since any zoosperms in the duct elaborated from the testicle before removal will, in all likelihood, be emitted. Male Birds have two testes, the left (female) being generally the largest, the most active, though occasionally the right is found to be. For the past year I have confined my experiments to chickens and rabbits. In order to hatch the eggs conveniently, in the winter time especially, I contrived an incubator, with which I have had great success. I procured a number of hens and roosters. The roosters that were to keep the hens company which were to lay eggs that would hatch out all pullets, these roosters were deprived of the right testicle. From the eggs obtained from the hens that were impregnated by these roosters I succeeded in hatching out nearly three hundred pullets, with not a rooster among them. Most of the hens were young that laid the eggs. In order to obtain male chickens (roosters), I removed the *left* testicle from the roosters which were to impregnate the eggs of the hens. From these eggs I obtained about forty male chickens, with no females among them. These results show that the determining factor of producing sex undoubtedly resides in the testicles of Birds, the right representing the male, the left the female principle. The process of reproduction in Birds, it is seen, is not so complex as in the higher order of animals. Thus, as a result of the development in Birds, *two* beings only can be produced, while in those that have two ovaries and two testicles, or more, there can be produced a greater variety, the number depending upon the various unions which may take place between the elements of the different testicles and different ovaries. In

another paper I assumed that there might be produced in animals of two testes and two ovaries, four different varieties or individuals; two would be typical, two non-typical. In animals that are not so constructed, as in monotremata, some marsupials, and all birds, two kinds only would be produced, male and female, typical, as their organization has not, in the long interval during its existence, demanded a more varied expression of organic life.

The organisms would be typical relatively speaking. In many instances there would not be a union, for various causes, or if a union, the offspring would not be strong and not able to cope with the various others in the struggle for an existence. Some of the zoosperms and ova might not be life-producing. In the above paper I have not entered into the question of one nature being capable of impressing the offspring mentally, physically or morally, more than another, nor touched upon the question of the influence of food, climate, season, etc., upon organisms; I shall reserve them for another paper.
